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Dated 2 November 2001

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1.	Your reference	SJA/57688/000
2.	Patent application number *(The Patent Office will fill in this part)*	**0113898.1**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	**Alpha Fry Limited** **Tandem House** **Marlowe Way** **Croydon** **CRO 4XS** **United Kingdom**
	Patents ADP number *(if you know it)*	7033640002
	If the applicant is a corporate body, give the country/state of its incorporation	**United Kingdom**
4.	Title of the invention	**IMPROVED PRINTING METHOD**
5.	Name of your agent *(if you have one)*	**BOULT WADE TENNANT**
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	**VERULAM GARDENS** **70 GRAY'S INN ROAD** **LONDON WC1X 8BT**
	Patents ADP number *(if you know it)*	**42001** ✓

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number (if you know it)	Date of filing *(day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application		Date of filing *(day / month / year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	**YES**		

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Continuation sheets of this form	
Description	9
Claim(s)	3
Abstract	
Drawing(s)	1 + 1

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(Please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature: Boult Wade Tennant

Date: 7 June 2001

12. Name and daytime telephone number of person to contact in the United Kingdom: **Susan J. Allard**
020 7430 7500

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IMPROVED PRINTING METHOD

The present invention relates to an improved printing method and in particular, to a method of fine pitch stencil printing in which a soldering flux vehicle is used which contains an additive to enhance fine pitch stencil printing.

There is a trend in the electronics industry towards the automated manufacture of printed circuit boards (PCBs) and towards the miniaturization of electronic devices with the requirement of finer and finer pitch devices. Solder paste is generally printed onto a substrate through a stainless steel or electroformed stencil. Industry standard stencils for PCB manufacture are generally from 0.10mm to 0.150mm in thickness and solder pastes comprising solder powder particles of 25 to 45 microns in diameter are required to print 0.25mm diameter apertures at a 0.5mm pitch.

Solder paste release from a stainless steel or electroformed stencil and subsequent printed pad definition on a PCB is influenced by the chemical nature of the solder paste and, in particular, the soldering flux vehicle. A solder paste has to have a certain amount of "tack" in order that components can be placed in position on the printed solder paste pads accurately and without loss. However, the tackiness of the solder paste which holds a component in position often prevents good printing of the solder paste onto a substrate through a stencil, i.e. good aperture release of the solder paste on printing may be prevented.

Accordingly, there is a requirement for an improved printing method using a solder paste formulation which has an improved release from a stencil during printing, whilst maintaining the internal tackiness of the solder paste thereby

preventing loss of components during the assembly placement of the components onto the PCB.

Accordingly, the present invention provides a method of printing a solder paste formulation onto a substrate surface through a stencil wherein a lubricant additive is included in the solder paste formulation in order to improve the release of the solder paste from the stencil.

The solder paste formulation is generally stencil printed onto the substrate surface using the following steps:

(a) placing a stencil over a substrate surface;

(b) printing a solder paste formulation containing a lubricant additive through the stencil; and

(c) removing the stencil from the substrate surface.

The stencil is preferably a stainless steel or electroformed stencil which generally has a thickness in the range of from 0.10mm to 0.150mm. The stencil used in the method of the present invention will generally have apertures of 0.20mm and above at a pitch of 0.40mm and above.

The lubricant additive which is incorporated into the solder pastes used in the method of the present invention is preferably selected from the group consisting of a fatty acid, a fatty alcohol, a fatty acid ester, a fatty alcohol ester, a mineral oil, a wax, a siloxone, a silicone or a micronised polytetrafluoro-ethylene powder.

Particularly preferred lubricant additives for use in the method of the present invention are those comprising a branched chain fatty alcohol or fatty acid, or an ester thereof, wherein the branch point is at the second carbon position. These compounds are generally known as Guerbet alcohols or Guerbet acids.

Specific examples of Guerbet alcohols and Guerbet acids for use in the method of the present invention are 2-butyl-1-octanol, 2-butyl-1-decanol, 2-hexyl-1-octanol, 2-hexyl-1-decanol, 2-hexyl-1-dodecanol, 2-octyl-1-dodecanol, 2-decyl-1-tetradecanol, 2-butyloctanoic acid, 2-butyldecanoic acid, 2-hexyldecanoic acid, 2-hexyldodecanoic acid, 2-octyldodecanoic acid, 2-decyltetradecanoic acid or 2-hexadecyleicosanoic acid.

The lubricant additive used in the solder paste formulations may be an ester of a fatty alcohol as defined above with a fatty acid, dibasic acid or tribasic acid. Examples are the stearates, oleates, palmitates, isostearates, adipates, trimellitates, thiodipropionates or pentaerythritol esters.

The solder paste compositions used in the method of the present invention will generally comprise from 75% to 95% by weight of solder powder, preferably 85% to 90% by weight of solder powder. The solder powder will generally have an average particle size in the range of from 10 to 80 micrometres, preferably 25 to 45 micrometres.

The solder paste is formed from a suitable alloy composition, for example an SnPb (such as Sn37Pb63), SnPbBi, SnBi, SnPbAg, SnAgCu, SnAgCuBi and SnZnBi.

The vehicle which is used in the compositions which are used in the present invention will generally comprise at least one polar organic solvent such as a polyhydric alcohol including ethylene glycol, diethylene glycol, propylene glycol, sorbitol, pentaerythritol and derivatives thereof, butyl diglyme, dibutyl itaconate, di(propylene glycol) butyl ether, 2-ethyl hexyl diglycol, γ-butyrolactone, hexyl carbitol, N-methyl pyrrolidone, N-ethyl pyrrolidone, terpineol or tetraglyme. Tri(propylene glycol) butyl ether is particularly preferred.

The vehicle will generally contain one or more

thickeners which enable the rheological characteristics of the vehicle to be modified, as required. Suitable thickeners include polyacrylic acid, hydrogenated castor oil and derivatives thereof, polyamides or resins which may be included in an amount of up to 30wt%.

It may be also be necessary for further components to be added to the vehicle to provide, for instance, fluxing activity for solder reflow. Typical fluxing additives which are known to those skilled in the art may be used. Activators may be included in the solder paste compositions in an amount of up to 7wt%. Other additives may include tackifier(s) and/or antioxidants and/or surfactants at a level of less than 5wt%.

The solder pastes which are used in the method of the present invention will generally contain from 0.1 to 2.0% by weight of the lubricant additive.

The advantage of the method of the present invention is that the solder pastes have an improved release from a stencil during printing and thus are adapted for use in fine pitch stencil printing.

The following non-limiting Examples illustrate the present invention.

EXAMPLES 1 TO 18

A number of flux gels were produced from the following components given in Table 1 and then mixed with solder powder (Sn62Pb36Ag2 of 25 to 45 micrometres diameter) to give a solder paste containing 10% flux gel and 90% solder powder.

Ex. No. Components	Comp.	1	2	3	4	5	6	7	8
	%	%	%	%	%	%	%	%	%
Rosin (KE604)	40	35	35	35	35	35	35	35	35
TPNB	54	54	54	54	54	54	54	54	54
Styrene dibromide	2	2	2	2	2	2	2	2	2
Thixatrol +	4	4	4	4	4	4	4	4	4
Isocarb 24		5							
Isocarb 36			5						
Isocarb ester 1605				5					
Kristol T60					5				
Paracera MW						5			
Isostearic acid							5		
Stearic acid								5	
Palmitic acid									5
Micronised PTPE									
200/100cS									
Dow Corning 704									
Isofol 24									

Ex. No. / Components	9	10	11	12	13	14	15	16	17	18
	%	%	%	%	%	%	%	%	%	%
Rosin (KE604)	35	35	35	35	35	35	35	35	35	35
TPNB	54	54	54	54	54	54	58	39	58	39
Styrene dibromide	2	2	2	2	2	2	2	2	2	2
Thixatrol +	4	4	4	4	4	4	4	4	4	4
Isocarb 24					2.5	4	1	20		
Isocarb 36										
Isocarb ester 1605					2.5	1			1	20
Kristol T60										
Paracera MW										
Iso stearic acid										
Stearic acid										
Palmitic acid										
Micronised PTPE	5									
200/100cS		5								
Dow Corning 704			5							
Isofol 24				5						

Footnotes to the Table

Rosin(KE604)	Arakawa	Acid modified hydrogenated rosin
TPNB	DOW	Tri(Propylene Glycol) Butyl Ether
Thixatrol +	Rheox	Rheological additive
Isocarb 24	Condea	2-decyltetradecanoic acid
Isocarb 36	Condea	2-hexadecyleicos-anoic acid
Isocarb ester 1605	Condea	2-hexyldecanoic acid-pentaerythritol ester
Kristol T60	Carless	Mineral Oil
Paracera MW	Industrial Waxes Ltd	Paraffin Wax
Micronised PTPE	Ranic Ltd	PTFE Micropowder
200/100cS	Dow Corning	Polydimethylsiloxane
Dow Corning 704	Dow Corning	Tetramethyltetra-phenyltrisiloxane and pentaphenyltri-methltrisiloxane
Isofol 24	Condea	2-decyltetradecanol

The 1st, 5th and 10th prints were visually examined and compared with a visual standard. In addition the appearance of the first print was recorded at 90 and 45 degrees using the SPIDA (Solder Paste Inspection Data Analyser).

The solder pastes were each printed through a series of 250 micrometre apertures using an electroformed stencil 0.125mm in thickness and an MPM AP27 printer.

The visual standard which was used to assess the print definition on inspection is described with

reference to Figure 1. Referring to Figure 1, T represents the stencil thickness, A the aperture diameter, D the paste diameter and H the paste height. The following scores were given.

SCORE	DESCRIPTION	VALUES
1	No paste or almost no paste	D<1/2A H<1/3T
2	More than ½ of pad area covered but insufficient height	D>1/2A H<2/3T
3	More than ⅔ pad area covered, paste reaches same height as stencil	D>2/3A H=T for <1/3A
4	More than ⅔ pad area covered and diameter of top is > ⅓ of aperture	D>2/3A H=T for <1/2A
5	Perfect deposit, same shape as stencil aperture	D = A H = T for > 2/3A

Results

The results of the visual inspections are given in Table 2 below.

TABLE 2

Example	Additive (%)	Score
Comparative	None	2
1	Isocarb 24	3
2	Isocarb 36	5
3	Isocarb ester 1605	4
4	Kristol T60	4
5	Pancera MW	4
6	Iso stearic acid	4
7	Stearic acid	3
8	Palmitic acid	4
9	Micronised PTFE	3
10	200/100cS	3
11	Dow Corning 704	3
12	Isofol 24	4
13	Isocarb 24 (2.5)/Isocarb ester 1605 (2.5)	4
14	Isocarb 24 (4)/Isocarb ester 1605 (1)	3
15	Isocarb 24 (1)	3
16	Isocarb 24 (20)	4
17	Isocarb ester 1605 (1)	3
18	Isocarb ester 1605 (20)	3

It can be seen from the results given in Table 2 that the solder pastes made with flux gels containing the lubricant additions showed improved print definition when compared with a paste made with a flux gel containing no lubricant addition.

CLAIMS:

1. A method of printing a solder paste formulation onto a substrate surface through a stencil wherein a lubricant additive is included in the solder paste formulation in order to improve the release of the solder paste from the stencil.

2. A method as claimed in claim 1 which comprises the steps of

(a) placing a stencil over a substrate surface;

(b) printing a solder paste formulation containing a lubricant additive through the stencil; and

(c) removing the stencil from the substrate surface.

3. A method as claimed in claim 1 or claim 2 wherein the stencil is a stainless steel or electroformed stencil.

4. A method as claimed in any one of the preceding claims wherein the stencil has a thickness of from 0.10mm to 0.150mm.

5. A method as claimed in any one of the preceding claims wherein the stencil has apertures of 0.20mm and above at a pitch of 0.40mm and above.

6. A method as claimed in any one of the preceding claims wherein the lubricant additive comprises a fatty acid, a fatty alcohol, a fatty acid ester, a fatty alcohol ester, a mineral oil, a wax, a siloxone, a silicone or a micronised polytetrafluoroethylene powder.

7. A method as claimed in claim 6 wherein the lubricant additive is a branched chain fatty alcohol or fatty acid containing a total of from 8 to 50 carbon atoms with a minimum of 4 carbon atoms being present in the shorter alkyl chain, or an ester thereof.

8. A method as claimed in claim 7 wherein the additive is a branched chain fatty alcohol or fatty acid wherein the branch point is at the second carbon position.

9. A method as claimed in claim 7 or claim 8 wherein the additive is 2-butyl-1-octanol, 2-butyl-1-decanol, 2-hexyl-1-octanol, 2-hexyl-1-decanol, 2-hexyl-1-dodecanol, 2-octyl-1-dodecanol, 2-decyl-1-tetradecanol, 2-butyloctanoic acid, 2-butyldecanoic acid, 2-hexyldecanoic acid, 2-hexyldodecanoic acid, 2-octyldodecanoic acid, 2-decyltetradecanoic acid or 2-hexadecyleicosanoic acid.

10. A method as claimed in claim 7 or claim 8 wherein the additive is an ester of a fatty alcohol as defined with a fatty acid, dibasic acid or tribasic acid.

11. A method as claimed in claim 10 wherein the ester is a stearate, oleate, palmitate, isostearate, adipate, trimellitate, thiodipropionate or pentaerythritol ester.

12. A method as claimed in any one of the preceding claims which comprises from 75% to 95% by weight of a solder powder.

13. A method as claimed in claim 12 wherein the solder powder is an alloy composition of SnPb, SnPbBi,

SnBi, SnPbAg, SnAgCu, SnAgCuBi, SnZnBi

14. A method as claimed in claim 12 or claim 13 wherein the solder powder has an average particle size in the range of from 10 to 80 micrometres.

15. A method as claimed in claim 14 wherein the solder powder has an average particle size in the range of from 25 to 45 micrometres.

16. A method as claimed in any one of the preceding claims wherein the solder paste comprises from 0.1 to 2% by weight of the lubricant additive.

FIG. 1.